# INVENTION DISCLOSURE

(WKRP Document No. 20010104.083046)

iMerlin

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|---|---|---|---|

IJS

| PD Number: 10011307 | Date Received by Legal: 01/08/2001 | Managing Attorney: CGR |
|---|---|---|

Invention Disclosure status: Submitted
0% Complete

General Information | Invention History | Description of Invention | Inventor Information | Witness Information | Additional Information | Administrative Record



## General Information

Section Complete

**Title:** Write a descriptive title of the invention.

*manufacturing procee for direct tunneling emitter*

**Abstract:** Write a brief abstract of the invention.

*A improved manufacture process was developed in this invention for direct tunneling electron emitter device. Compering first generation process, this invention provides much better pad to pad isolation, resolved top to bottom electrod shorting issue, and improves device yield from ~ 5 % to 40 %. The pad to pad isolation is improved by using metal etch to replace trench oxide etch. The top to bottom electrod shorting is resolved by redesign the process flow and using thin dielectric lift-off process. The device yield is improved by adding an annealing process at end. With optimizing annealing condition, th edevice yield is improved significantly*

**Projects:** Select projects associated with disclosed invention.

*Orca*

**Products:** Select product names or numbers associated with this invention.

*MIS flat emitter*

## Invention History

Section Complete

**Published:** Was a description of the invention published, or are you planning to publish? If so, when and in what publications?

*No*

**Announced:** Was a product including the invention announced, offered for sale, sold, or is such activity proposed? If so, when and where?

*No*

**Disclosed:** Was the invention disclosed to anyone outside of HP, or will such disclosure occur? If so, when and to whom?

*No*

**Urgency:** Will the invention be published, announced, or disclosed in the next 3 months?

*No*

**Described:** Was the invention described in a lab book or other record?

*Yes*
*In electron files and lab note book*

**Built:** Was the invention built, modeled, or tested? If so, when?

*Yes*
*November 11, 2000*

**Government Contract:** Was the invention made under a government contract?
If so, the agency and contract number:

1307a

No

## Description of Invention
Section Complete

**Prior Solutions:** List prior solutions and their disadvantages.

*In the first generation direct tunneling process, there were following issues*
*1 oxide trench etch process was used for isolation, but it did no provide good isolation between emitters, and pad to pad, because of good step coverage of metal deposition. It resulte in poor isolation ( ~ 10 ohm was measured between pad to pad)*
*2. The thin emission layer was deposited before first layer metal etch. Therefore, extremly high selectivity is required for the metal etch process. Due to very thin emission layer (50 - 100 A) is needed for direct tunneling device, the reqriement is very difficult to meet. And top to bottom electrod shorting is a big issue.*
*3.there was no annealing in the process. Therefore, interface is not well conditioned between fist and second layer metal, as well as the interface between emission layer and N++ silicon*

**Problems Solved:** Explain the problems solved by the invention.

*In this invention, isolation between emitters is improved from 10 Ohm in prior solotion to greater than 30 MOhm in this invention. Top to bottom shorting issue is resolved by redesign the process flow and using dielectric lift off process. This change in process flow remove the high selectivity requirement for metal etch process. The device yield is improved from ~5 % to 40% by implimenting and optimizing an annealing process*

**Advantages:** What are the advantages of the invention over what has been done before?

*The improved manufacturing process in this invention provids much better isolation between emitters, resolved top to bottom electrod shorting , and resolted in high device yield*

**Description:** Describe the construction and operation of the invention.

*A improved manufacture process was developed in this invention for direct tunneling electron emitter device. Comparing first generation process, this invention provides much better pad to pad isolation by using second layer metal etch to replace oxide trench etch. And it resolved top to bottom electrod shorting issue by redesign process flow (emission thin film is deposited after first layer metal etch, and apply dielectric lift off process. Finally, improved device yield from ~ 5 % to 40 %, by adding an annealing process at end. With optimizing annealing condition, th edevice yield is improved significantly*

## Inventor Information
Section Complete

**Inventor(s):** Pursuant to my (our) employment agreement, I (we) submit this disclosure:

| | | |
|---|---|---|
| Chen, Zhizhang (John) [00306262]<br>Corvallis, OR, USA | Telnet: 715-1143<br>Location Code: 6410-5335 | john_chen2@ex.cv.hp.com<br>Added by Chen, Zhizhang (John) on 1/5/01 |
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| Ramamoorthi, Sriram [00305761]<br>Corvallis, OR, USA | Telnet: 715-1142<br>Location Code: 6410-5335 | sriram_ramamoorthi@ex.cv.hp.com<br>Added by Chen, Zhizhang (John) on 1/5/01 |
| Regan, Michael [00306086]<br>Corvallis, OR, USA | Telnet: 715-0588<br>Location Code: 6410-5350 | mike_regan@ex.cv.hp.com<br>Added by Chen, Zhizhang (John) on 1/5/01 |

**Inventor Home Addresses:** Enter the home address of each Inventor. This information is legally required to process your Invention Disclosure.

| Inventors | Home Street Address | City | State/ Province | Zip/ Postal Code | Country |
|---|---|---|---|---|---|
| Chen, Zhizhang (John) | 4411 Snowbrush Dr. | Corvallis | OR | 97330 | United States [US] |
| Johnstone, Mark A | 33949 Bond Rd | Lebanon | OR | 97355 | United States [US] |
| Ramamoorthi, Sriram | 5062 SW Technology Loop, Apt 91 | Corvallis | OR | 97333 | United States [US] |
| Regan, Michael | 3210 NW Arrowood | Corvallis | OR | 97330 | United States [US] |

**Inventor Citizenships:** Select the country of citizenship for each Inventor.

| Inventors | Country of Citizenship |
|---|---|
| Chen, Zhizhang (John) | United States [US] |
| Johnstone, Mark A | United States [US] |
| Ramamoorthi, Sriram | India [IN] |
| Regan, Michael | United States [US] |

**Inventor Mail Stops:** Enter the HP Mail Stop for each Inventor.

| Inventors | HP Mail Stop |
|---|---|
| Chen, Zhizhang (John) | MS113A |
| Johnstone, Mark A | MS113 |
| Ramamoorthi, Sriram | MS113A |
| Regan, Michael | MS10318 |

**Non-HP Inventors:** Please list the names, home addresses, telephone numbers, email addresses, and countries of citizenship of inventors who are not affiliated with HP.

## Witness Information
Section Complete

**Witnesses:** This invention has been explained to and understood by the following witnesses.

Liao, Hang [00306348]
Corvallis, OR, USA

Telnet: 715-8074
Location Code: 6410-5335

hung_liao@ex.cv.hp.com
Added by Chen, Zhizhang (John) on 1/5/01

**Witness Dates:** At what date was this invention first explained to and understood by each witness?

| Witnesses | Date Understood |
|---|---|
| Liao, Hang | January 3, 2001 |

## Additional Information
Section Complete

**Electronic Documents:** Do you have electronic document files to upload?

| File Name<br>Click to View | Size<br>Bytes | Uploaded<br>Date | Uploaded By<br>User |
|---|---|---|---|
| MIS1.ppt | 119296 | 1/5/01 | Chen, Zhizhang (John) |

**Paper Documents:** Do you have paper documents to include with your Invention Disclosure that you would like to send by FAX?

**Categories:** Select WKRP categories where this invention disclosure should be indexed.

*Manufacturing Technologies: Fabrication*

**Keyword(s):** Select keywords to index this invention disclosure.

*MIS direct tunneling emitter*

**Invention Workshop:** Was this Invention Disclosure prepared as a result of an Invention Workshop? If you are not sure, select *No*.

Yes

| **Administrative Record**<br>7 Required Fields Remaining |
|---|
| **Legal Admin**: Select the name of the Legal Admin(s) working on this Invention Disclosure: |
| |
| **PD Number and Legal Received Date**: Record the PD number assigned by Merlin and modify the date this disclosure was received, if necessary. |
| |
| **Patent Coordinator(s)**: Select Patent Coordinator(s) who will work on this Invention Disclosure: |
| |
| **Managing Attorney(s)**: Select Managing Attorney(s) assigned to this Invention Disclosure: |
| |
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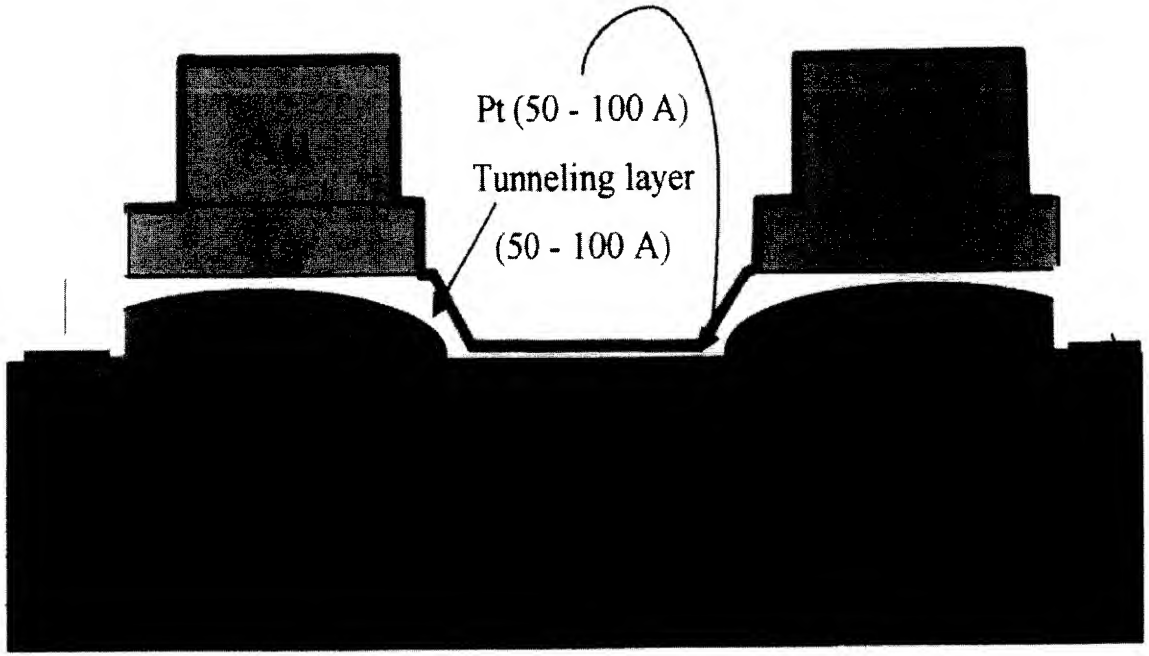
# Direct Tunneling MIS emitter process

Orca.cv




**First generation process**

1.define emission area by FOX

2. emission layer deposition

3. Ta/Au deposition

4. Metal 1 photo patterning

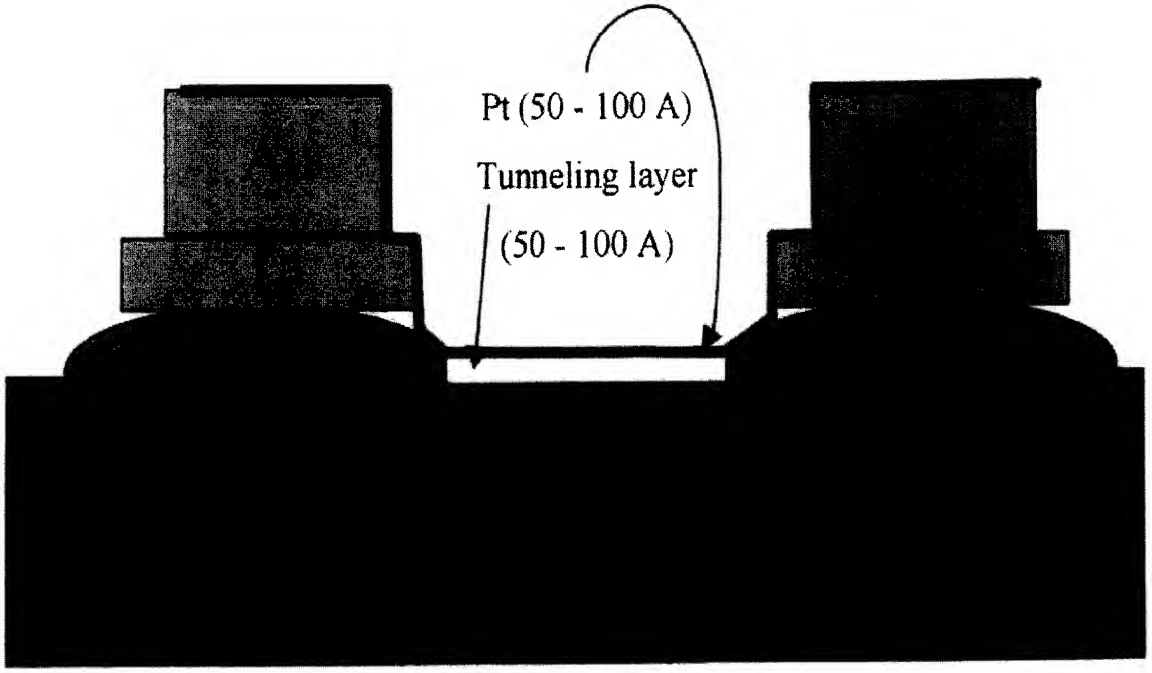
5. Au wet etch

6 Ta dry etch

7. trench photo

8.oxide trench etch

9. Top thin metal deposition




## Improved process

1.define emission area by FOX

2. Ta/Au Deposition

3. Metal 1 photo patterning

4. Au wet etch

5 Ta dry etch

6. Tunneling layer dep./lift off

7. Top thin metal dep.

8. trench photo

9 .thin metal etch (or lift-off)

10. anneal